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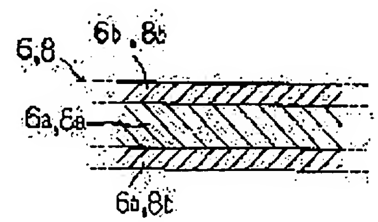
(54) BATTERY AND LITHIUM ION SECONDARY BATTERY

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a battery which can increase a weight energy density value by lightening battery weight without decreasing strength of a collector.

SOLUTION: A positive electrode collector constitutional unit 6 is formed by a resin-made film 6a of polyethylene terephthalate formed with a positive electrode collector (conductive thin film) 6b composed of a aluminum evaporation layer in both surfaces. A negative electrode collector constitutional unit 8 is formed by a resin-made film 8a of polyethylene terephthalate formed with a negative electrode collector (conductive thin film) 8b composed of a copper evaporation layer in both surfaces.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a cell and a rechargeable lithium-ion battery.
[0002]
[Description of the Prior Art] Generally, the laminating of a positive-electrode plate and the negative-electrode plate is carried out through an electrolyte layer, and the cell is constituted. Moreover, in recent years, the rechargeable lithium-ion battery is used as a rechargeable battery of high capacity and a high energy consistency. The rechargeable lithium-ion battery is used abundantly at portable devices, such as a VTR camera, a notebook computer, and a cellular phone, taking advantage of the advantage of high capacity and the amount energy density of Takashige. What the laminating was carried out to the electrolyte layer which consists of a separator which sinks in the nonaqueous electrolyte in which the positive-electrode plate which uses as an active material the matter (lithium content oxide etc.) which carries out occlusion emission of the lithium ion as this kind of a rechargeable lithium-ion battery, and the negative-electrode plate which makes the carbon material (graphite) which carries out occlusion emission of the lithium ion negative-electrode material dissolved lithium salt, and was constituted is known. As a concrete example, the paste which contains $LiCoO2$ (matter which carries out occlusion emission of the lithium ion) in the positive-electrode charge collector which consists of metallic foils, such as aluminum foil, is applied, and the positive-electrode plate is made. Moreover, the paste which contains a carbon material (graphite) in the positive-electrode charge collector which consists of metallic foils, such as copper foil, is applied, and the negative-electrode plate is made. Moreover, the so-called winding type wound where the laminating of a positive-electrode plate and the negative-electrode plate is carried out through an electrolyte layer may constitute this kind of rechargeable lithium-ion battery.
[0003]
[Problem(s) to be Solved by the Invention] However, the common cell had a limitation, in order the weight rate of the charge collector occupied in the weight of the whole cell was large and to have raised the weight energy density of a cell. In the rechargeable lithium-ion battery which can make especially a weight energy density high, it has been a big technical problem to raise the weight energy density of a cell further. Moreover, in the case where it winds where the laminating of a positive-electrode plate and the negative-electrode plate is carried out through an electrolyte layer, in order to use a band-like plate, there was a problem that the weight rate of the charge collector occupied in the weight of the whole cell became large especially.
[0004] The purpose of this invention is to make weight of a charge collector light and offer the cell which can raise a weight energy density value, without reducing the reinforcement of a charge collector.
[0005] Other purposes of this invention are to make weight of a charge collector light and offer the rechargeable lithium-ion battery which can raise a weight energy-density value, without

reducing the reinforcement of a charge collector.
[0006]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, in this invention, weight of a charge collector is made light, without reducing cell energy or reducing the reinforcement of a charge collector. That is, the conductive thin film formed in the front face of the film made of resin or the sheet made of resin constitutes one [at least] charge collector of a positive-electrode plate and a negative-electrode plate. Since specific gravity is small compared with metallic foils which used the film made of resin, or the sheet made of resin conventionally, such as aluminum foil and copper foil, the film made of resin or the sheet made of resin (henceforth a current collection construct) in which the conductive thin film was formed on the front face is light compared with the conventional charge collector. And since the film made of resin has the flexibility and reinforcement which are not inferior to the conventional charge collector (metallic foil), a current collection construct can maintain the same reinforcement as the conventional charge collector.
[0007]
[Embodiment of the Invention] This invention constitutes one [at least] charge collector of a positive-electrode plate and a negative-electrode plate with the conductive thin film with which the positive-electrode plate and the negative-electrode plate were formed in the front face of the film made of resin, or the sheet made of resin for the cell which comes to carry out a laminating through an electrolyte layer. Where the laminating of a positive-electrode plate and the negative-electrode plate is especially carried out through an electrolyte layer, in winding, in order to use a band-like plate, the weight rate of the charge collector occupied in the weight of the whole cell becomes large. Therefore, by making weight of a current collection construct light, the weight of the whole cell becomes remarkably light and can make weight energy density of a cell high. In addition, when winding in this way, a conductive thin film is formed in both sides of the film made of resin, or the sheet made of resin.
[0008] As the film made of resin, or a sheet made of resin, what consists of the quality of the material of polyethylene terephthalate (PET), polyimide, polypropylene, etc. can be used. A conductive thin film should just choose the quality of the material with proper aluminum thin film, copper thin film, etc. according to a cell.
[0009] A conductive thin film can be formed with vacuum evaporationo, sputtering, plating, etc. If a conductive thin film is formed by vacuum evaporationo, a conductive thin film can be formed thinly and weight of a charge collector can be made light on an effective target. Moreover, a conductive thin film is firmly joinable to the film made of resin.
[0010] Although it is applicable to various kinds of cells, if this invention is applied to a rechargeable lithium-ion battery, since this invention can raise further the weight energy density of the cell of a rechargeable lithium-ion battery, it can extend further the use range of a rechargeable lithium-ion battery. If it applies to the rechargeable lithium-ion battery wound where the laminating of a positive-electrode plate and the negative-electrode plate is especially carried out through an electrolyte layer, weight energy density of a cell can be made high on an effective target. What is necessary is just to use a copper thin film as a conductive thin film of a negative-electrode charge collector, using an aluminum thin film as a conductive thin film of a positive-electrode charge collector, when applying this invention to a rechargeable lithium-ion battery.
[0011] In addition, when forming a conductive thin film in both sides of the film made of resin, the terminal of a plate is formed so that it may connect with each conductive thin film. Moreover, what is necessary is just to form the terminal of a plate so that it may connect with either of the double-sided conductive thin films when the through hole was formed in the current collection construct, it is made to flow through a double-sided conductive thin film electrically, or a conductive thin film is formed also in the edge of the film made of resin and it

is made to flow through a double-sided conductive thin film electrically.
[0012]
[Example] Hereafter, the example of this invention applied to the winding type rechargeable lithium-ion battery with reference to the drawing is explained to a detail. Drawing 1 is the vertical section end view of the winding type rechargeable lithium-ion battery of this example. As shown in this Fig., the winding type rechargeable lithium-ion battery of this example has the structure where the winding type group of electrode 1 was contained in the cell can 2. The winding type group of electrode 1 has the structure wound so that the positive-electrode plate 3 and the negative-electrode plate 4 might carry out a laminating through the electrolyte layer 5. The positive-active-material layers 7 and 7 are formed in both sides of the positive-electrode current collection construct 6, and the positive-electrode plate 3 is constituted, and has the 0.22mmx50mmx450mm dimension. The charge collectors (vacuum-plating-of-aluminium layer) 6b and 6b with a thickness of 1 micrometer are formed, and the positive-electrode current collection construct 6 is constituted by both sides of film 6a of polyethylene terephthalate (PET) with a thickness of 10 micrometers, as shown in the expanded sectional view of drawing 2 . In this example, it vapor-deposited as follows. First, the tungsten filament which twisted film 6a and aluminum in the vacuum evaporationo interior of a room is arranged so that it may counter mutually in the distance of about 10cm. Next, the vacuum evaporationo interior of a room was decompressed with the vacuum pump, and the vacuum evaporationo interior of a room was made into the vacua of 10-5 - 10-6mmHg. Next, after gasifying and removing the impurity which has adhered the current to the tungsten filament with a sink and primary heating to the tungsten filament, aluminum was steam-ized with secondary heating. This formed the vacuum-plating-of-aluminium layers 6b and 6b in both sides of film 6a. The positive-active-material layer 7 is formed with mixture with the binder which consists of an electric conduction assistant which consists of $LiCoO_2$ (matter which carries out occlusion emission of the lithium ion), and graphite, and polyvinylidene fluoride (PVDF). The positive-active-material layer 7 has the thickness of 100 micrometers, and nonaqueous electrolyte sinks into the interior. In this example, the positive-active-material layer 7 was formed as follows. First, $LiCoO_2$ Graphite and PVDF were mixed by the weight ratio of 80:10:10, and optimum dose **** and this were fully kneaded for the distributed solvent which becomes this from a N-methyl-2-pyrrolidone. Thereby, it is $LiCoO_2$. Graphite and PVDF made the so-called kneading object of the shape of ink distributed in the N-methyl-2-pyrrolidone. Next, after plastering both sides of the positive-electrode current collection construct 6 with this kneading object by roll-to-roll imprint, this was dried and the positive-active-material layer 7 was formed in both sides of the positive-electrode current collection construct 6.
[0013] The negative-electrode material layers 9 and 9 are formed in both sides of the negative-electrode current collection construct 8, and the negative-electrode plate 4 is constituted, and has the 0.22mmx50mmx450mm dimension. Like [the negative-electrode current collection construct 8] the positive-electrode current collection construct 6, as shown in the expanded sectional view of drawing 2 , the charge collectors (copper vacuum evaporationo layer) 8b and 8b with a thickness of 1 micrometer are formed and constituted by both sides of film 8a of polyethylene terephthalate (PET) with a thickness of 10 micrometers. In this example, copper was used instead of aluminum, and others performed vacuum deposition like the positive-electrode current collection construct 6, and formed the copper vacuum evaporationo layers 8b and 8b in both sides of film 8a. The negative-electrode material layer 9 is formed with mixture with the binder which consists of graphite of 5 micrometers of mean diameters which carry out occlusion emission of the lithium ion, and polyvinylidene fluoride (PVDF). The negative-electrode material layer 9 has the thickness of 100 micrometers, and nonaqueous electrolyte sinks into the interior. In this example, the negative-electrode material layer 9 was formed as follows. First, graphite and PVDF were mixed by the weight ratio of 90:10, and optimum dose

**** and this were fully kneaded for the distributed solvent which becomes this from a N-methyl-2-pyrrolidone. Thereby, graphite and PVDF made the so-called kneading object of the shape of ink distributed in the N-methyl-2-pyrrolidone. Next, after plastering both sides of the negative-electrode current collection construct 8 with this kneading object by roll-to-roll imprint, this was dried and the negative-electrode material layer 9 was formed in both sides of the negative-electrode current collection construct 8.
[0014] It sinks into the separator which consists of a polyethylene film of fine porosity, nonaqueous electrolyte is constituted, and the electrolyte layer 5 has the thickness of 10 micrometers. Nonaqueous electrolyte is one mol [/l.] LiPF6 to the whole electrolytic solution to the solvent which mixed ethylene carbonate and carbonic acid JIETEREN by the volume ratio of 1:1. In addition, it made.
[0015] The positive-electrode current collection construct 6 is electrically connected to positive-electrode cap 2a of the cell can 2 through the positive-electrode tab terminal 10. Moreover, the negative-electrode current collection construct 8 is electrically connected to negative-electrode **** 2b of the cell can 2 through the negative-electrode tab terminal 11. The positive-electrode tab terminal 10 has connected electrically both vacuum-plating-of-aluminium layers 6b and 6b and positive-electrode cap 2a which were formed in both sides of film 6a of the positive-electrode current collection construct 6. Moreover, the negative-electrode tab terminal 11 has also connected electrically both and negative-electrode **** 2b of the copper vacuum evaporationo layers 8b and 8b which were formed in both sides of film 8a of the negative-electrode current collection construct 8. In addition, a through hole can be formed in the positive-electrode current collection construct 6 and the negative-electrode current collection construct 8, it can be made to be able to flow through a double-sided conductive thin film electrically, or a conductive thin film can be formed also in the edge of Films 6a and 8a, and it can also be made to flow through a double-sided conductive thin film electrically. In this case, what is necessary is just to form a positive-electrode tab terminal and a negative-electrode tab terminal so that it may connect with either of the double-sided conductive thin films.
[0016] Assembly of the cell of this example was performed as follows. First, after having arranged the winding type group of electrode 1 which attached the positive-electrode tab terminal 10 and the negative-electrode tab terminal 11 in negative-electrode **** 2b of the cell can 2, the positive-electrode tab terminal 10 was welded to positive-electrode cap 2a, and the negative-electrode tab terminal 11 was welded to the wall of negative-electrode **** 2b. Next, nonaqueous electrolyte was poured in negative-electrode **** 2b, and nonaqueous electrolyte was sunk into the two-poles plate and the separator. Next, the cell of this example was completed for positive-electrode cap 2a in total through the insulating gasket 12 to opening of negative-electrode **** 2b.
[0017] Next, in order to investigate the property of the cell of this example, the cell of the example of a comparison was made and it examined using each cell of this example and the example of a comparison. Others made the cell of the example of a comparison like the cell of this example using the copper foil of the same thickness (20 micrometers) as the negative-electrode current collection construct 8 instead of the negative-electrode current collection construct 8 using the aluminium foil of the same thickness (20 micrometers) as the positive-electrode current collection construct 6 instead of the positive-electrode current collection construct 6.
[0018] And in 25 degrees C, by 4.2V (100mA of upper limit currents), each cell of this example and the example of a comparison was discharged in 25 degrees C according to 100mA (termination electrical-potential-difference 2.8V) constant current, after [20 hours] carrying out constant-potential charge. The capacity of 1200mAh(s) was obtained for both cells. Moreover, it asked for the weight energy density of each cell from the capacity and discharge voltage of each cell. Table 1 shows the measurement result.

[0019]
[Table 1]

	集電構成体重量 (g)	電池重量 (g)	重量エネルギー密度 (Wh/kg)
実施例	3.23	43.0	100
比較例	5.23	45.0	96

From this table, although the discharge capacity of the cell of this example is the same as that of the cell of the example of a comparison, since it can make cell weight light, it is understood that weight energy density is raised. Since it is small compared with the consistency (2.7) of aluminum, and a copper consistency (8.92), the cell of this example makes weight of a current collection construct light compared with the cell of the example of a comparison, and the consistency (1.38) of PET can make weight of a cell light.
[0020] Moreover, PET is 730 kg/cm2. Although it is small compared with the tensile strength (7x105 kg/cm2) of aluminum, and copper tensile strength (110x109kg/cm2) since it has tensile strength, PET has the reinforcement which can bear enough the force (4 - 5 kg/cm2) of joining a charge collector in application of an active material and winding of a plate.
[0021] In addition, although the conductive thin film formed in the front face of the film made of resin constituted both the positive-electrode charge collector and the negative-electrode charge collector from this example, either [at least] a positive-electrode charge collector or a negative-electrode charge collector may be constituted in this way.
[0022] Hereafter, the configuration is shown about invention indicated on the specifications.
[0023] (1) $LiCoO_2$ which carries out occlusion emission of the lithium ion at a positive-electrode charge collector The positive-electrode plate which it comes to fill up, In the winding type lithium secondary battery which it comes to wind where the laminating of the negative-electrode plate with which it comes to fill up the graphite which carries out occlusion emission of the lithium ion is carried out to a negative-electrode charge collector through the electrolyte layer containing nonaqueous electrolyte It is the winding type lithium secondary battery characterized by coming to consist of said positive-electrode charge collector vacuum-plating-of-aluminium film formed in both sides of polyethylene terephthalate, and constituting said negative-electrode plate charge collector with the copper vacuum evaporationo film formed in both sides of polyethylene terephthalate.
[0024]
[Effect of the Invention] Since specific gravity is small compared with metallic foils which used the film made of resin, or the sheet made of resin conventionally, such as aluminum foil and copper foil, the film made of resin or the sheet made of resin (current collection construct) in which the conductive thin film was formed on the front face is light compared with the conventional charge collector. And since the film made of resin has the flexibility and reinforcement which are not inferior to the conventional charge collector (metallic foil), a current collection construct can maintain the same reinforcement as the conventional charge collector. Therefore, according to this invention, the weight energy density of a cell can be raised, without reducing the reinforcement of a charge collector.

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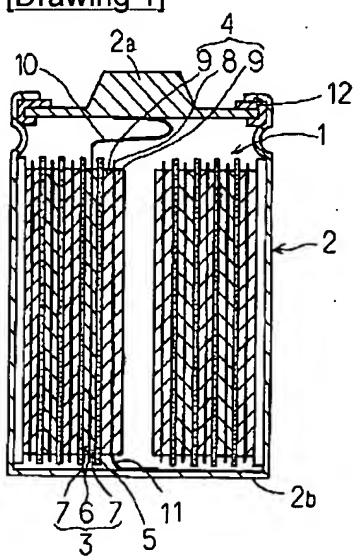
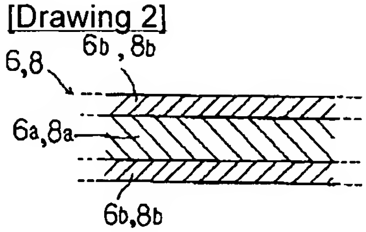
DRAWINGS

[Drawing 1]



[Drawing 2]



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